Title: Pulsed Lidar for Measurement of CO2 Concentrations for the ASCENDS Mission - Update
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Abstract:
We have been developing a laser-based sounding technique for the remote measurement of the tropospheric CO2 concentrations from orbit for NASAís ASCENDS mission. The missionís goals are to provide measurements of tropospheric CO2 abundance with global-coverage, a few hundred km spatial and monthly temporal resolution. These are needed to better understand CO2 fluxes and the processes that regulate CO2 storage by the land and oceans. For the IIP, we are developing and demonstrating the lidar techniques and key lidar technology that will permit measurements of the CO2 column abundance in the lower troposphere from aircraft. Our final goal is to demonstrate the key capabilities needed for a space lidar and mission approach for the ASCENDS mission. We use a pulsed lidar technique, which is much less sensitive to errors from cloud and atmospheric scattering and to noise from solar background. It allows continuous measurements of CO2 mixing ratio in the lower troposphere during day and night.

Our approach uses the 1570nm CO2 band and a two-wavelength laser absorption spectrometer, which continuously measures at nadir from a circular polar orbit. It directs the narrow co-aligned laser beams from the instrument's lasers toward nadir, and measures the energy of the laser echoes reflected from land and water surfaces. It uses a pair of tunable laser transmitters, which allowing measurement of the extinction from a single selected CO2 absorption line in the 1570 nm band and from a line pair in the Oxygen A-band near 765 nm. These regions have temperature insensitive absorption lines are free from interference from other gases. The lasers pulse at 10 KHz, use tunable diode seed lasers followed by laser amplifiers, and have MHz spectral widths. During the measurement the lasers are stepped across the selected lines at a kHz rate. The receiver uses a 1-m class telescope and photon sensitive detectors and measures the background light and energies of the laser echoes from the surface. The extinction and column densities for the CO2 and O2 gases are estimated from the ratio of the on and off line echo pulse energies via the integrated path differential absorption (IPDA) technique. Our technique exploits the atmospheric pressure broadening of the lines to weight the measurement sensitivity to the atmospheric column below 5 km. Pulsed laser signals, time gated receiver are used to isolate the surface laser echo signals and to exclude photons scattered from clouds and aerosols.

We have successfully demonstrated many key aspects of the approach and lidar technology in the laboratory. We have demonstrated CO2 column measurements in airborne flights during the summers of 2009 and 2010. These included measurements from 3- 13 km altitudes made over a variety of surfaces and through thin and broken clouds. We demonstrated initial airborne measurements of O2 column density to 10 km altitudes during the summer 2010 flights. More details approach, key technologies, and demonstration measurements will be given in the presentation.

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